R009-07
B 会場 ：9/26　 AM2 （10:45-12:30）
10:45～11:00

# 彗星コマ中の D/H 観測を目的とした共鳴吸収型フィルタの開発

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# Development of Absorption Cell Filters for D/H Observations in Cometary Comae

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The deuterium to hydrogen abundance ratio (D/H ratio) within hydrogen corona of planets and small celestial bodies is essential for understanding their formation processes and atmospheric escape processes. We conducted experiments aimed at improving the measurement accuracy and lifetime of absorption cell filters; these are developed for spectroscopic observations of hydrogen coronae from spacecrafts.

The absorption cell is a filter that absorbs the hydrogen Lyman-alpha line (H Ly-α) emitted by hydrogen atoms through resonant scattering. It is a cylindrical glass cell of which both bottom surfaces are made of $MgF_2$, and hydrogen gas is filled within. When tungsten filaments that are attached in the cell are tuned on, the hydrogen gas thermally dissociates into atoms, which resonantly scatter H Ly-α that enters the cell; the resonant scattering results in the absorption of H Ly-α in the line of sight. Since there is a 33 pm difference in wavelengths of H and D Ly-α, H and D cells selectively absorb these emissions respectively. This allows separate measurement of hydrogen and deuterium densities in the corona.

However, there are mainly two issues with the absorption cell: 1) absorption of H Ly-α by the D cell, and 2) instability in absorption due to filament lifetime. Regarding 1), a small contamination of $H_2$ gas mixing into the D cell causes apparent increase in the brightness of D Ly-α. Filament oxidation due to introduction of water and oxygen into the cell causes 2). The oxidation would also lead to an increase in filament resistance; therefore, the temperature rises, giving the need to consider its impact on the dissociation rate of hydrogen molecules.

To address these issues, we developed a system using getters and cold traps to ensure the enclosure of pure $H_2$ and $D_2$ gases within the cells. Getters were introduced to remove $H_2$ gas from the vacuum line before enclosing $D_2$ gas, as a measure against 1). Cold traps, on the other hand, were introduced to remove water and oxygen from the vacuum line, as a preventive measure against 2). Species dependence of these adsorption effects was quantitatively evaluated in an experiment using a quadrupole mass spectrometer.

The absorption cell filter will be integrated into an ultraviolet spectroscopic imaging device; this will be installed on the Comet Interceptor spacecraft to observe cometary coma of a long-period comet. Numerical evaluations were conducted to determine the conditions for ensuring the measurement accuracy of D/H observations that will be necessary for achieving mission objectives: specifically, the upper limit of the abundance ratio of $H_2$ gas relative to $D_2$ gas enclosed within the D cell. Furthermore, the filament lifetime was evaluated through an experiment by varying power supplied to the filament to ensure fulfillment of the mission purposes. Additionally, the absorptance of H Ly-α by the D cell will be measured to quantitatively discuss the achievable accuracy of D/H observations.